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Variability of Tropical Climates

By STEPHEN S. VISHER, Ph.D. (Chicago).

Introduction.

IN the standard texts of meteorology and climatology it is commonly stated that tropical climates are extremely uniform. They indeed have comparatively slight seasonal variations in temperature and in the length of day and night, and large areas have rather steady winds, much of the time. But in my opinion this continual emphasis upon uniformity is misleading because there are important variations in temperature and wind, while the rainfall of the lower latitudes appears to be more variable, on the average, than the rainfall of higher latitudes. There likewise appears to be more variation in storminess and in rapid change of air pressure than in higher latitudes.

Tropical Ranges in Temperature.

Although the average seasonal range in temperature is indeed small in low latitudes as compared with middle latitudes, there is, in latitudes more than 10° or 15° from the equator, an appreciable seasonal contrast. Indeed some few cities near the tropics have about as great a seasonal range of temperature as certain especially uniform parts of higher latitudes. This is illustrated when the average differences in mean temperature between the three warmest months and the three coolest, of the following pairs of seaport cities are compared. New Orleans is not within the tropics according to the narrowest limitation of that zone, but is within the belt dominated by the trades during

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most of the year, which is the belt commonly considered as the tropical.

SEASONAL RANGE OF TEMPERATURE.

Table 1.

Hongkong	range	20° F. v.	Glasgow	range	12° F. ;	22° N v. 56° N
Brisbane	,,	17° F. v.	Hobart, Tas.	,,	15° F. ;	27° S v. 43° S
New Orleans	,,	26° F. v.	Vancouver	,,	22° F. ;	30° N v. 49° N

Even in regard to extremes of temperatures, some cities in fairly low latitudes have ranges which approach (or equal in a few cases) those of the less variable parts of relatively high latitudes. This is illustrated by the following table showing the difference between the highest and lowest temperatures ever officially recorded at certain pairs of seaport cities up to a recent year.

EXTREME RANGE OF TEMPERATURE.

Table 2.

Calcutta	range	64° F. v.	Dublin	range	74° F. ;	22° N v. 53° N
Rio de Janeiro	,,	52° F. v.	Wellington	,,	58° F. ;	23° S v. 42° S
Durban	,,	71° F. v.	Dunedin, N.Z.	,,	71° F. ;	29° S v. 46° S
New Orleans	,,	95° F. v.	Sitka	,,	90° F. ;	30° N v. 57° N

That there are appreciable seasonal contrasts in temperature in lower latitudes is not surprising when the seasonal variation in insolation is considered. In spite of the fact that the sun shines vertically somewhere between the two tropics every day in the year, there is a great change in the angle of incidence. Few people realise that when the sun is vertically over the northern tropic (Cancer), it shines upon the southern tropic (Capricorn) less nearly vertically by 4 degrees than upon the Arctic Circle. The latitude of Switzerland receives much more heat from the sun on June 21st than does the equator, for not only is the sun as nearly vertical in latitude 47° N as at the equator, but the days are almost four hours longer.

Although, on the average, tropical regions show less seasonal change of temperature than do middle latitudes, the reverse is true in respect to daily range. The night has been called the winter of the tropics. The daily range is considerable in all lower latitudes although it is far less in the more humid regions, such as occur along the equator, than in the more arid. On the average it is distinctly greater than the normal range in higher latitudes. This is due to two chief influences. Day and night are more nearly equal in length and hence there is a closer balance between heating and cooling than occurs in higher latitudes, where the nights are too short in summer for marked cooling and the days are too short in winter for effective heating. The other great cause is the higher average temperature, since the escape of heat varies as the 4th power of the absolute temperature. This means that normally there is much greater cooling per nocturnal hour wherever the daytime temperature is

high than where it is low. A third reason why the diurnal range is greater in low latitudes (below 30°) is that a larger proportion of the area is arid or semi-arid than is the case in middle latitudes. In the tropics the nights often become so cool that considerable discomfort results. Even in an insular climate like that of Suva, Fiji (latitude 18° S), in spite of the wind blowing off the sea, and a rainfall of over 100 inches fairly evenly distributed throughout the year, it commonly becomes so cool at night that the sensitive residents wear wraps if they walk out late in the evening. Indeed even the heavy army overcoats are frequently worn with comfort at night and in the early morning during the cooler season. In drier parts of the tropics, the nights become much cooler than in a humid locality like Suva. On the dry western sides of the Fiji Islands, for example, temperatures below 40° F. have been recorded near latitude 16° S, close to sea level, and in dry continental areas frost is not unknown near sea level, as for example within 20° from the equator in Australia and Africa.

Another type of marked cooling in the tropics is the sudden drop, often as much as 6° F. or 8° F., which occurs in thunderstorms, which are very frequent in many parts of the tropics, and are far commoner here on the average than in higher latitudes. Sometimes, as when hail falls in quantity, the temperature-drop is much greater. Hail storms are not very rare in some tropical localities. For example, ten hail storms were reported in ten years in latitudes 13° S to 16° S, near sea level, in the northern Territory of Australia. Three hail storms occurred in Panama (latitude 9° N) in a twelve year period.

Cold snaps of still other types occur within the tropics. For instance, cold winds sometimes sweep down from higher latitudes and bring low temperatures surprisingly near the equator. Zero temperatures have been officially recorded in subtropical northern Florida (latitude 30° N), and a temperature of only 10° above zero F. has occurred on the Gulf Coast of Mexico in latitude 25·5° N. Central coastal Queensland is subject to "severe frosts" during four months of the year, within 21° of the equator, while freezing temperatures have occurred even in the daytime in south-eastern Asia in latitude 22° N at sea level. Still farther south, on the China Sea, near Manila, latitude 15° N, northerly gales in winter occasionally make overcoats welcome even in daytime. Similar cold snaps occur in the cooler months in other tropical localities such as the Hawaiian Islands, Jamaica and Fiji. Indeed, the Weather Bureau reports a snow flurry practically at sea level at Mahukona, Hawaii (latitude 20° 11′ N) lasting ten minutes on December 29th, 1921. Perhaps even more surprising is the great cooling reported as not rare in winter on the coast of Venezuela, when in latitude 10° N gales

from the north, off the sea, occasionally bring day temperatures of 45° F. or even less.

Because of the sensitiveness of the residents of the tropics to low temperatures, chills and colds often develop and sometimes pneumonia. Many observers have been impressed by the abundance of coughs and catarrh in the tropics: they may be more common there than in Canada. Indeed there is considerable truth in the saying that "cold causes more suffering in the tropics than in polar or subpolar regions."

Variations in respect to the Winds.

Now as to the winds: Five chief sorts of variation within the tropics merit attention. (1) Even when the direction is fairly constant, there is a marked diurnal variation in velocity. Calm nights are the rule in trade wind deserts, and nearly calm nights are common elsewhere on the land except upon exposed elevations. Likewise at sea, while the diurnal range is less than on land, it is notable. For example, Tetens reports a diurnal range of over 50 per cent. in the velocity of the wind at Samoa. In higher latitudes, while the wind frequently dies down at nightfall and normally weakens, windy nights are by no means uncommon and very frequently the wind is stronger by night than by day. In the tropics windy nights occur on lowlands only during the passage of rather rare severe cyclonic storms. Moreover, disturbances of an intensity which would give strong nocturnal winds in middle and high latitudes cause only moderate winds at night at low elevations in the tropics. This is due to the influence of the comparatively great decrease in vertical convection at night in low latitudes, caused by the greater cooling of the surface air than of the overlying free air. It is for this reason also that even relatively steep barometric gradients in monsoonal regions permit a marked dying down of the surface winds at night.

(2) Seasonal as well as diurnal variations in the velocity of the trades are common. "Half gales" are characteristic of Fiji, the New Hebrides, and many other South Pacific groups in their spring months, and even "whole gales" are frequent during the north-east "monsoons" in the China Sea during winter. On the other hand, in other months, calms or light breezes are the rule when the doldrums migrate past, as they do twice each year with the seasonal change in the altitude of the sun. Along the margins of the tropics, calms likewise occur when the extra-tropical belt of high pressure migrates equatorward in the cooler season.

(3) There is a radical seasonal change in the direction of the trades when they cross the equator; those crossing from the north change from east-north-east winds to north-west, owing

to the deflective effect of the earth's rotation. Consequently many places near the equator have easterly winds much of the year ; calms while the doldrums are migrating past and westerly winds when the doldrums are situated in higher latitudes on their side of the equator. Then as the sun returns equator-ward, calms and easterlies recur.

(4) Another evidence of tropical variability is that land and sea breezes are more characteristic of the lower latitudes than of the higher. This is because the contrast in the temperature of land and water averages greatest in low latitudes. Indeed, while in middle and high latitudes sea breezes are rare except during the hottest weeks, in many parts of the lower latitudes they occur almost every day in the year and give a wind regime which is very different from the constant easterly trades supposedly characteristic of the tropics. The monsoons are a special type of land and sea breezes, since they blow towards the land for many consecutive weeks during summer and in the opposite direction in winter. While produced by temperature contrasts of extra-tropical regions, the monsoons are most strongly felt in tropical latitudes (below 30°) and give large and important regions a sharp seasonal contrast in wind directions. Between the winter and the summer monsoons, there commonly is a spell, several weeks in length, when the winds are irregular and often light. After they become steady in direction, they often fluctuate notably in velocity from day to day as well as between day and night.

(5) Although winds due to cyclonic disturbances do not occur so frequently within the tropics as in higher latitudes, they are significant. The "boxing of the compass," during which the wind comes from every direction in turn, occurs many times a year in most parts of the tropics, while occasionally cyclonic gales or even violent hurricanes occur. Official Japanese daily weather maps and annual summaries of storm tracks show an average of over fifty tropical cyclonic disturbances a year in east longitudes 115°—145°, while a study of the Australian daily weather maps for 20 years shows an average of over 30 a year in similar longitudes south of the equator. Thus in less than one-seventh of the circumference of the earth there are over 80 cyclonic disturbances in an average year. This is, however, the stormiest sector.

Mention should also be made of thunder squalls which are more violent in low latitudes than in higher latitudes on the average, and more frequent. In addition, several regions in subtropical latitudes experience tornadoes or similar storms. Thus it is evident that there is considerable variation in respect to winds in the tropics. (*To be continued*).

Royal Meteorological Society

THE monthly meeting of the Society was held on Wednesday, June 20th, at 49, Cromwell Road, South Kensington, Dr. C. Chree, F.R.S., President, in the chair.

Messrs. J. E. Clark and I. D. Margary. Report on the Phenological Observations in the British Isles for the year 1922.

In this, the 32nd report (New Series), the authors had to deal with an exceptionally cool and sunless summer (after mid-June) with much rain in July and August. The mild winter of 1921-22 was followed by a cold early spring, making the fruit blossom late and giving an expectation of excellent crops. The heat and sunshine of the latter part of May and of early June resulted, however, in a rapidity of flower and insect development rarely experienced in our island, and, with the accompanying drought, injured the hay crop, spring oats, &c. The harvest generally was late, especially in the north, the oat harvest in north Scotland only ending with November.

The isophene flower chart and the migrant records show that the divergence from the 30-year average was, however, not very large, so great was the acceleration due to May and June. As a consequence of the previous very favourable summer and still more favourable October for wood ripening there was a remarkable display of blossom and fruit. But, as Mr. Hooker pointed out in the discussion, what was more striking was the abundance of fruit which had remained on during the winter, so that this year hawthorns were in flower and fruit at the same time. It was a contradiction of the old proverb that the abundance of fruit foretells a hard winter.

Dr. T. G. Longstaff.—Meteorological Notes from the Mt. Everest Expedition of 1922.

In this paper Dr. Longstaff explained that they were able to make few meteorological observations on the expedition, but that a more or less systematic record of temperature was kept on the outward march, at the base camp at 16,500 ft. and at the various climbing camps. The day temperatures were taken with sling thermometers, and the night ones with minimum thermometers exposed to the sky on wooden boxes about one foot above the ground. The lowest reading recorded was $-12°$ F. on May 27th at Camp III., at a height of 21,000 ft. Dr. Longstaff pointed out that his notes referred only to April, May and part of June, and on the northern side of the main Himalayan range. Totally different conditions prevail on the southern side, and the change from one to the other is extraordinarily abrupt. On the north of Mt. Everest the snow level is put at 20,000 ft., and above 25,000 ft. sublimation takes place. Even at 16,000 ft. a covering of snow four inches deep disappeared in an hour or two.

Probably the constant high winds assist this. During the discussion, Dr. Simpson pointed out that many of the phenomena observed were familiar to him in the Antarctic. The existence of glaciers indicated that sublimation did not keep pace with the snowfall. The antisolar rays which had been pictured by Dr. Longstaff were to be seen in all parts of the world, and not only at high altitudes.

Correspondence

To the Editor, *The Meteorological Magazine*

A Brilliant Halo: June 30th

At 7 a.m. (G.M.T.), at Purley, a faint but nearly complete halo was noted. At 10.30, in the City, it was seen as an exceptionally fine circle, the bright inner (red) margin sharply cut and contrasting strongly with the blue purple of the uniformly darker interior sky, which continued to within 7° or 8° of the sun. The outer margin of the halo was also well marked, as the blue of the ring was very clear.

Watching it again at Purley at 11.15 the ring was not quite so sharply defined and the contrast of interior darkness was less marked. The halo haze layer seemed rather denser, and detached heavier cloud forms began to obscure the halo at times, but at 11.20 it was clearer, and then it was noticed that on either side the lower quadrants were double, bulging arcs lying outside the halo circle proper. On the right this was perfect, from rather above the sun level to nearly below it. The interspace, at about 45° with the vertical between the inner (red) edges, was 1° to 1½°. To the left the outer arc was only partly developed, from contact just below the horizontal to the same 1° or 1½° at 45°, disappearing a little lower. The halo below, between these two arcs, was fairly sharp, and the semicircle above very well defined. By noon (G.M.T.) the lower clouds obscured the higher levels.

J. Edmund Clark.

41, Downscourt Road, Purley, 30th June, 1923.

[The observation does not seem to be entirely consistent with any phenomenon described in works on meteorological optics. With the elevation of the sun about 60° the upper and lower "tangent arcs" of the 22° halo join and form a single curve, approximately an ellipse. According to Pernter's computations the separation of this circumscribed halo from the circular halo is about 2° where the radius is 45° from vertical and about 3° where the radius is horizontal. Mr. Clark's "bulging arc" agrees in the separation at 45°, but it makes "contact just below the horizontal."—Ed. *M.M.*]

The Exposure of Raingauges

In an article on the exposure of raingauges in the *Meteorological Magazine* for October, 1922, Lieut.-Colonel E. Gold refers to an experiment carried out at Valencia Observatory by Mr. L. H. G. Dines, in which a raingauge was exposed in a conical hole in such a manner that i s rim was on a level with the surrounding ground. He gives the result obtained: That during a period when the ordinary gauge caught 335 mm. the gauge in the hole caught 387 mm., an excess of about 15 per cent. There is, however, a factor which appears to have been overlooked in this connection. Lieut.-Colonel Gold's remarks indicate that the comparison was a simple one of the measured rainfalls from the two gauges. The magnitude of the excess, together with a knowledge of the sites made me suspect that this direct comparison was not sufficient, and that a difference between the catches of the two gauges might be found even when both were exposed in the ordinary manner, that is to say, each with its rim one foot above the ground. Fortunately data were available for testing this suspicion, as the experimental gauge had been exposed at the same spot in the ordinary manner for a year previous to its being placed in a hollow.

I have taken out the monthly totals for the two gauges for the year February, 1921, to January, 1922, both inclusive, during which time they were both exposed on their present sites with the rim in each case one foot above the surrounding surface. The results show that my suspicion was well founded, as during the twelve months the ordinary gauge caught 1,238 mm. while the experimental gauge caught 1,288 mm., an excess of 4 per cent. A very brief examination of the monthly totals was sufficient to show that the difference was for the most part a winter phenomenon. I give therefore the data divided into two portions, the first including the months April to September inclusive, the second, the remaining six months.

	Control Gauge.	Experimental Gauge.	Excess.
April—September ...	408 mm.	417 mm.	2 per cent.
October—March ...	830 mm.	871 mm.	5 per cent.
Total... ...	1,238 mm.	1,288 mm.	4 per cent.

These figures give a measure of the preliminary allowance which must be made for "site" before considering the difference between the readings of the two gauges when one is placed in a hollow. It is fortunate, therefore, that in effect we are able to compare the catches of one gauge in the different circumstances at the same time.

The results for the twelve months February, 1922, to January, 1923, both inclusive, when the experimental gauge was in a

hollow, are as follows; the readings from the 1st to the 5th of February being omitted for both gauges, owing to some uncertainty as to their true values.

	Control Gauge.	Experimental Gauge in Hollow.	Excess.
April—September ...	594 mm.	642 mm.	8 per cent.
October—March ...	614 mm.	704 mm.	15 per cent.
Total... ...	1,208 mm.	1,346 mm.	$11\frac{1}{2}$ per cent.

Thus, after allowing for "site difference" the excess becomes about 6 per cent. for the summer months and 10 per cent. for the winter months with a mean excess for the twelve months of about $7\frac{1}{2}$ per cent. The division of the year gives roughly the half characterised by light winds and that characterised by strong winds; and the figures show experimentally the effect which Lieut.-Colonel Gold pointed out as following from theoretical considerations, namely, that in-splashing will increase with increasing wind.

The results given above show that the excess of 15 per cent. quoted in Lieut.-Colonel Gold's article is much too high; being at least double the average excess which might be expected if the sites were similarly exposed, which is only 7 to 8 per cent. If the invitation to amateur rainfall observers to undertake investigations into the matter of gauge exposures results in such investigations being undertaken, it will be well for the observers to understand the uncertainties which may arise in comparisons between two independent raingauges. It is proposed now to make a further test for twelve months with the sides of the hole cut vertically instead of in the form of a cone.

C. D. STEWART.

Valencia Observatory, Cahirciveen, Kerry, February 5th, 1923.

1921 and 1923 compared with 1865 and 1867

MR. BROOKS looks* to the hot summer of 1921 for an explanation of the ice in the Atlantic in May, 1923, and to that ice to account for the long spell of cold weather that we have lately experienced.

It may, therefore, be of interest to carry the parallel between 1923 and 1867 a little further, for 1865 had also a fine hot summer, and more particularly it had an exceptionally hot brilliant September, with no rain at all at very many stations. I cannot quote figures, for I had not then begun to keep records. The first number of this Magazine did not appear till February, 1866. Also in the Preface to *British Rainfall*, of 1866, Mr. Symons speaks of it as the 7th volume that he had produced, and that volume is the earliest which I possess. But in *British Rainfall*

* *Met. Mag.*, vol. 58, June, 1923, p. 100.

for 1891, on page 22, Mr. Symons couples September, 1865, with February, 1891, these two being at many stations rainless months, but he is not in that passage concerned with its temperature. Some references to its heat are found in *British Rainfall*, 1898. The Septembers of 1895 and of 1898 were also very fine and very hot, but they did not come up to that of 1865.

I remember well the succession of glorious days, the abnormal heat, the bright sunshine and the cloudless skies. But in those days people could enjoy its splendour in blissful ignorance of the consequence that a fleet of icebergs would invade the Atlantic in May, 1867, and cause ruinous frosts in England.

Yet, per contra, it must not be forgotten that after the exceptionally hot and dry summers of 1868, 1893 and 1911, no such results followed, for the late spring and also the summer both of 1870 and of 1895 were hot and dry, and 1913 was a quite respectable year.

H. A. BOYS, F.R.Met.Soc.

Spring Hill, St. Mary Bourne, June 20th, 1923.

[Reference to *British Rainfall*, 1865, shews that May, July and August, were all wet months. The stations with no rain in September were scattered over a large area in the south of England; they were numerous in Devon and Somerset and also in Norfolk.—ED. *M.M.*]

May Weather

THE article in the June number of the *Meteorological Magazine* by Mr. Brooks on the causes of the cool spring and summer (so far) of the present year, raises one or two points. The recent weather conditions are held to be a result of the abnormal summer of 1921. Ten years earlier the British Isles experienced an even more abnormal summer—the wonderful summer of 1911 (said to be the warmest on record), but two years later, in 1913, we did not experience a cold spring or a cool summer. My recollection is that the summer of 1913 was a fine warm season. Then again, if an abnormal summer tends to produce a cool season two years afterwards, how are we to account for the occurrence in the past of two or three consecutive years with warm seasons, *e.g.*, 1857, 1858 and 1859? An explanation of these singular occurrences would be welcomed by many.

FREDERICK J. PARSONS.

County Observatory, Ross-on-Wye, June 27th, 1923.

Mr. Parsons's letter brings out the necessity for taking a very wide view of the sequence of weather. The conditions of May, 1923, were traced back to two causes—the abnormally low pressure in the Arctic Ocean during the summer of 1921 and the abnormally high pressure in the Azores anticyclone during the winter of

1921-22. The term "abnormal summer of 1921" was applied to the general pressure distribution from Spitzbergen to the Azores, incidentally including the British Isles, and it is the general distribution that counts. A fine British summer is not necessarily associated with low Arctic pressure, and in 1911, the first instance cited by Mr. Parsons, Arctic pressure was rather high. Moreover the winter of 1911-12 was characterised by an abnormally low barometer at the Azores, not high as in 1921-22. Thus in May, 1913, we should expect to find a general pressure distribution the reverse of that found in May, 1923, *i.e.*, low over the Atlantic and high over northern Europe, and this is in fact what happened.

During the drought of May to October, 1887, pressure was generally low over the Arctic Ocean, and the early months of 1889 were marked by high pressure in the North Atlantic. On the other hand in the winter of 1887-88 pressure was rather low instead of high over the Azores, and the barometric minimum between Iceland and Norway was not developed in the spring of 1889. Thus each month or season presents a separate problem, which cannot be solved by analogy with a past month or season over a limited area. In fact the article indicates that the weather of any particular time is a function of preceding conditions not only over a long interval of time, but also over a large part of the earth's surface. The pressure data at hand are insufficient for a discussion of 1857, 1858 and 1859.

C. E. P. BROOKS.

Anemometer Pens

THERE is frequently trouble in getting a new pen to write with certainty when first inserted in the holder of the Pressure Tube Anemometer. Some pens are worse than others, and nearly all settle down after a few days, but meanwhile the record is sometimes lost.

A method which is often useful is to temper the nibs in the part near the slot, leaving the actual points hard as before; then press the nibs down on a hard surface, as in the act of writing, until they separate rather widely. On examining the pen it will be found that the two halves have separated by a very minute amount, leaving a very fine crack through which light can be seen. One or two trials may be necessary before this is achieved, and it is important that the crack should be exceedingly narrow, in fact at the extreme point the two halves ought practically to touch. Such a pen will then generally give a good trace from the start, provided that it is set square with the paper. In the figure the tempered part is shown between A and

B, and should be heated over a very small flame until the blue colour reaches B; then cool it to prevent softening of the writing points *pp*. The operation requires a little practice at first as the crack may be made too wide, but, if so, it may be reduced by pressing the nibs as before, but upside down. They should also be in perfect alignment with each other when the pen is looked at from the side.

L. H. G. DINES.

Benson Observatory, Wallingford, April 28th, 1923.

Meteorology and Folklore

Dawn and Sunset Colours, Cloud Shadows, etc.

DAWN and sunset have had such a strong influence upon the active life of primitive man that their importance must have been early recognised. They are accompanied too with such lovely colour effects that it is no wonder that Homer spoke of "rosy-fingered" Eos, and that some beautiful Vedic hymns are addressed to Ushas, young, immortal, born afresh each day, with ruddy steeds yoked to her shining car. Less satisfactory have been the attempts to interpret other legends as "dawn-myths," since in mythology, as elsewhere, theories are good servants but bad masters.

The inhabitants of the Sandwich Islands say that once upon a time the Sun-God Ra, was very irregular in his rising and setting to the inconvenience of humanity. So the great hero Maui determined to set things right. He plaited six stout ropes of cocoanut fibre and laid them in the Sun's way. The Sun fell into the traps, and became so tangled up that he was glad to purchase his liberty by promising to become more regular in his habits. Maui let him go, but as a reminder the ropes were left hanging round him. "These ropes may still be seen hanging from the sun at dawn and when he descends into the ocean at night. By the assistance of the ropes he is gently let down into Avaiki (the land of shades) and in the morning raised up out of the shades: while the islanders still say when they see rays of light diverging from the sun 'Tena te Taura a Maui' ('Behold the ropes of Maui')." In England these cloud-shadows are known as "the sun drawing water," or as the Danes say "Locke (Loki) is drawing water."

. . . .

It is not in the least extraordinary that water-spouts, which combine a strange appearance with very real danger, should have given rise to a crop of legends. They form the basis of Arab tales of "tinnin" or sea-monsters, which are the same as the Hebrew "Tannin" (E.V. "whale," "dragon") which in Ps. CXLVIII, 7, might in the context be appropriately rendered

"water-spouts." African natives have a tale that "God" draws up bad whales to heaven with a water-spout.

. . . .

St. Paul sailed for Italy in a boat whose sign was Castor and Pollux. The ancients identified the twins with St. Elmo's fire and believed that the appearance of two "flames" in a storm was a good omen for they indicated the presence of the brothers and the safety of the ship.

"Safe comes the ship to harbour
Through billows and through gales,
If once the great Twin Brethren
Sit shining on her sails."

One light was called "Helen" and regarded as of ill omen. With the advent of Christianity the Mediterranean seamen transferred the phenomenon to the guardianship of their patron saint St. Erasmus, whose name has been corrupted into St. Elmo. Hence also the English name "corposants" (corpo santo). Perhaps it was in this form that, in the "Tempest," Ariel "boarded the king's ship"

"Sometime I'd divide
And burn in many places; on the topmast,
The yards, the borespit, would I flame distinctly
Then meet and join."

CICELY M. BOTLEY.

10, *Wellington Road, Hastings, May 24th, 1923.*

NOTES AND QUERIES

Meteorological Exhibit at the Royal Agricultural Show, Newcastle, July 3rd to 7th, 1923

As in previous shows, the Agricultural Education Exhibition arranged in connection with the Royal Agricultural Society's Show, at Newcastle, included an exhibit by the Meteorological Office. The space, under cover, allotted for the purpose permitted an adequate display of apparatus, diagrams, and publications, as well as a demonstration of local forecasting from data picked up by wireless telegraphy. In the open, a complete climatological observing station was set up and observations were made regularly. In its general features the display was therefore similar to that given last year at Cambridge.

The issue of forecasts on the spot was only made possible by local co-operation in arranging for the wireless reception. These arrangements were kindly undertaken by Mr. G. Littlefield, of Armstrong College, under the general supervision of Prof. W. M. Thornton.

The assistance of three other gentlemen, Messrs. Bird, Waring and Scrimshaw, who acted as operators, must also be gratefully acknowledged. The receiving apparatus was most adequate,

and on only one occasion, when the Air Ministry synoptic message was badly jammed by a neighbouring station, was it necessary to obtain supplementary information from London. The weather charts for each morning and afternoon were reproduced on a large blackboard, similar to that at the Air Ministry. Forecasts and readings taken on the Show-ground were written up alongside.

The Show afforded an opportunity of making the general public acquainted with the existing facilities for obtaining forecasts by wire, telephone and radio-telephony. Although the forecasts distributed by telephone already run to many thousands per month the great majority of the public still seem to be ignorant of this new facility.

H.R.H. the Prince of Wales, with the Duke of Northumberland, inspected the exhibit on Wednesday, July 4th, and expressed his interest in what he saw. The general public attended the Show in immense numbers; if only one visitor out of two found his way into the Agricultural Education Building the exhibit must have been seen by a hundred thousand people. E.G.B.

The International Meteorological Conference

THE sixth International Conference of the Directors of Meteorological Institutes and Observatories will be held at Utrecht, by the invitation of Professor E. van Everdingen, Director of the Dutch Meteorological Institute, during the week September 7th to 13th, 1923. Among the subjects for discussion by the Conference are "The reduction of Atmospheric Pressure to Mean Sea Level," brought forward by Dr. Hesselburg; "Discipline of wireless operations to obviate jamming," brought forward by Mr. T. F. Claxton; and "Daily Synoptic Charts for the Southern Hemisphere (South Atlantic)," and "Verification of Daily Weather Forecasts," brought forward by Dr. M. Sampaio Ferraz.

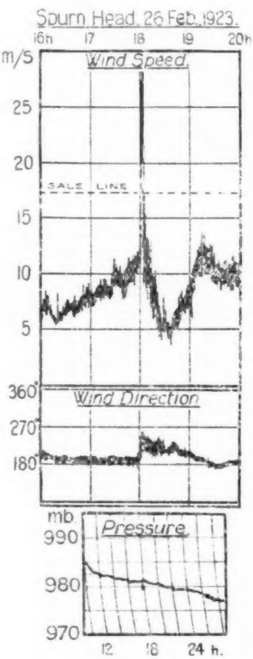
Meetings of several of the International Commissions have been arranged for the preceding week.

The Commission for Agricultural Meteorology	Sept. 3rd to 6th.
The Commission for Solar Radiation ...	Sept. 4th to 6th.
The Commission for Terrestrial Magnetism and Atmospheric Electricity	Sept. 6th.
Joint Meeting of the Commissions for Weather Telegraphy, and for Maritime Meteorology	Sept. 5th to 6th.

Members of the Commissions for the Investigation of the Upper Air and for the study of Clouds who have taken part in the Conference of Directors are asked to meet at Utrecht on September 14th and 15th to discuss the questions referred to them by the Conference.

Effect of Wind Suction in Lighthouses

It has long been realised that the pressure indicated by a barometer placed in a lighthouse tower is not representative of the pressure in its neighbourhood. The pressures reported from such meteorological stations as Dungeness and Spurn Head are frequently lower than those from stations where the barometers are in buildings less exposed to the wind. As a general rule the differences are not conspicuous on the daily weather maps, but in drawing a map illustrating the average distribution of pressure for a month the meteorologist has to make allowance for the irregularity. Other local differences are "smoothed" out in the process of averaging, but this effect is persistent and becomes more marked the longer the series of observations. It is estimated that the mean pressure computed from observations made in the Dungeness lighthouse is too low by about 0·5 millibar in January, by about 0·4 millibar in July.



The effect in question is to be attributed to the eddying of the wind round the lighthouse. It is well known that in pressure-tube anemometers, suction is produced by the wind as it blows over holes perforated through the walls of a vertical tube. Experiments in the laboratory have shown that the air pressure is high on the windward side of such a tube, and low in the eddies on the leeward side: the low pressure occurs on more than half the circumference of the tube, and, as will be realised by anyone who watches the eddies forming in water as it flows past a bridge pier, the lowest pressure is on the flanks. On the average there is a deficiency of pressure, *i.e.*, the pressure is lower inside the tube than in the free air. The lighthouse tower acts as such a suction-tube, the crannies, for example those round the windows, serving for the transmission of pressure. The opening of windows complicates matters; if the open window is on the windward side pressure will be raised, if it is on the lee side suction will be more in evidence, but the most interesting point is that with all windows closed suction is to be expected.

It is not only in the readings of the mercury barometer that the effect in question is to be detected ; the curves produced by barographs show unmistakably the rapid variations of pressure under the influence of the wind. An example in which the magnitude of the disturbance could be determined with unusual precision occurred at Spurn Head on February 26th. At 18h. G.M.T. on that day a line squall passed the lighthouse. The squall lasted but a few minutes ; the wind as recorded by the Dines anemometer rose from 25 miles per hour to 63. The record from the barograph indicates that pressure fell by 2 millibars and rose immediately by the same amount, fall and rise being indistinguishable on the chart. There is some doubt whether the door in the base of the tower, which faces north-west, was open at the time of the squall. If so, the suction produced by the wind, which blew from south or south-west, would have operated under favourable conditions. If the door was not open at the time, the suction must have taken effect through the lantern or other openings into the tower. Though such exact agreement is no doubt fortuitous, it is curious that this measurement of 2 millibars is in precise accordance* with the formula given by experiment for the suction produced in the head of the Dines anemometer.

Experiments are being made by the Meteorological Office with a barometer house designed so as to overcome the effect of eddies in exposed situations.

Yankee Enterprise

"*Tycos*," the quarterly house-journal of the Taylor Instrument Companies of Rochester, New York, is largely devoted to popular meteorology, and serves the excellent purpose of keeping dealers in scientific instruments in touch with the subject.

The April number contains a dozen articles of interest to meteorologists. The leading article is the most exciting. It is entitled "Where the Bottom Fell Out of the Sky," and is reprinted from *Popular Science Monthly*. It is stated that the deluge in question "occurred a few months ago over a region of four square miles, within the watershed of Sand Canyon, a gorge descending from the Sierra Nevada Mountains in southern California. Within the space of half-an-hour it is estimated that 240 inches of rain fell on this small area." We were not surprised to learn from a well-known American meteorologist that the Weather Bureau was unable to confirm this estimate.

* The formula is $S = \frac{1}{4}\rho v^2$, where S is the suction, v is the velocity of the current, and ρ is the density of the air. (Corless : *Dictionary of Applied Physics*, Vol. III., p. 504). Using C.G.S. units we have $\rho = \cdot 0012$ grms/cm³, $v = 1100$ cm/sec before the gust, 2800 cm/sec in the gust and the change in S is 2000 dynes per square centimetre, *i.e.*, 2 millibars.

An Epic of the South East Trades

The voyage of the crew of the *Trevissa* in two small lifeboats across the Indian Ocean is one of the most remarkable that has been made for many years. As will be remembered, the *Trevissa* foundered in a SSW gale at midnight on June 3rd, in Long. 85° 42′ E. and Lat. 28° 45′ S, more than 1,200 miles from the nearest land. Being not far from the south-east trade wind area the Captain decided to take advantage of these winds to make Mauritius. From the 5th to the 9th the boats steered west-north-west, but strong winds and high seas compelled them to lay to for several hours at a time, and on the night of the 9th, when rain was falling very heavily, the two boats were unable to keep each other in sight. On the 10th the Captain's boat reached the trade wind area, and for the first time they had a favourable wind, but this was followed by four days' calm. Then bad weather with high seas and strong squally south-east trade winds prevailed and the boat was driven too far north. Eventually they worked back and landed at Rodriguez. The second boat, in charge of the First Officer, passed wide of Rodriguez owing to the bad weather, and reached southern Mauritius 250 miles further on, having covered a distance of about 2,000 miles. In his account of his adventure, the First Officer says: "The south-east trade winds were baffling, being inconstant in direction and strong enough at times to force us to reef our small sail, and the boat's compass was put out of action almost as soon as the boat was lowered."

A Bird's Song in Relation to Light

Colonel H. S. Rawson, whose experiments on the effect of light on plant growth are well known, has recently* recorded some remarkable observations illustrating the response of the thrush to early morning light.

The intensity of the light was standardised in a curious way. Colonel Rawson observed in a prism the image of a window-frame, and noted when his eyes could distinguish coloured fringes bordering the framework. He found in 25 cases out of 26 that the song of the thrush commenced within a minute of the fringes becoming visible. Sometimes the interval was only a few seconds. Such a striking agreement in the sensitiveness of the human eye and the bird's merits further investigation.

* Transactions of the Hertfordshire Natural History Society, etc., vol. xvii., part 4, 1923.

† It is not quite clear whether the window-frame was observed or the trunks of the trees. The optical phenomenon is surely to be explained by the unequal refrangibility of light of different colours, not as the author suggests, by diffraction.

The Reform of the Calendar

THE Editor of the *Bulletin of the American Meteorological Society* has been so good as to devote two pages of his April number to an account of the *Meteorological Magazine*. One paragraph in this article deals with the summary published in the magazine of a discussion on the Reform of the Calendar.

> "The 13-month new calendar, which has received such support from American meteorologists, under the leadership of Professor C. F. Marvin, was adversely criticized at a meeting of the Royal Meteorological Society. The arguments directed against the American proposal were (1) that the year could no longer be conveniently quartered and halved; (2) that the traditional characters of the months would be seriously altered. Neither of these objections will appeal to Americans, for (1) the year could easily be quartered and halved for meteorological purposes by taking units of 13 weeks each. The preparation of quarterly or semi-annual summaries would come at times when the preparation of monthly values was not on deck; (2) American traditions have not yet become very firmly rooted to particular weather for particular months. A move of a few hundred miles makes more of a change in the weather usually than does two weeks of the season's progress. England is noted for its "unseasonable" weather, so why should a shift of a month to a fortnight earlier or later be noticeable even there?"

These answers to the objections do not seem to us to be adequate. In the experience of the Meteorological Office there is always useful work awaiting computers when the preparation of monthly values is not "on deck." In the study of climate, and especially of rainfall, statistics for individual weeks are only computed for comparatively few stations; the month is the usual unit; to ordain that values for the summer and winter half years are only to be obtained by reference to figures for the weeks is to add untold unnecessary labour.

As to our unseasonable weather, does not the very word indicate that we have our ideas as to what is seasonable?

The frequency of Solar Halos

IN the *Annales des Services Techniques d'Hygiène* for 1922, M. Louis Besson gives the results of twenty years observations on halos at Paris (Montsouris). Halos occur much more frequently than would be supposed by the uninitiated, an average of 129 halos of 22° being observed each year between the hours of 7h. 30m. and 19h. 30m., *i.e.*, one every third day. The largest number occur in the early summer, an average of 15 per month

being recorded in April and of 14 per month in May and June, while the least number are seen in January and November. The halo of 46° is a much less general phenomenon, being recorded at Paris on an average 8 times a year.

The only station in the British Isles at which observations of halo phenomena are made with assiduity comparable with that shewn at Montsouris, is the Radcliffe Observatory, Oxford. The summary of observations for this Observatory for 1922 (Q. J. R. Met. Soc., Vol. XLIX, No. 206, p. 135), shows that halos of 22° were seen on 147 days during the year (parhelia being present on 25 days) and halos of 46° twice.

Climatological Stations in Scotland

It was recently noted* that three of the oldest and most important of the Scottish voluntary climatological stations (Arbroath, Glencarron and Inverness) had come to an end, and that it had been found possible to replace each of these stations by another under public or municipal control. Now another break has occurred with the termination of the valuable series of observations made at Fort William by Mr. W. T. Kilgour. A great enthusiast, Mr. Kilgour became a resident of Fort William in the early days of the Ben Nevis Observatories, and frequently acted as a voluntary observer on the summit of the mountain. His handbook, "Twenty Years on Ben Nevis," is an admirable record of a great achievement. Shortly after the observatories were closed in 1904, Mr. Kilgour offered his services as a voluntary observer at Fort William, and his work has been throughout of the highest quality. Recently he indicated that he could not continue to act, and the familiar name of Fort William will now disappear from the Monthly and Weekly Weather Reports, for, unfortunately, the municipality do not see their way to accept the view that the maintenance of a meteorological station is a public obligation.

With the co-operation of The Forestry Commission (Scotland) a new station has been established at Inchree near Onich. This station is situated only 8 miles from Fort William, and will adequately replace the latter as a "District Value" station. Following a now well-established custom, the observer attended a course of instruction at King's College Observatory, Aberdeen. It may be noted that it was found impossible to arrange at Onich for observations at the traditional hours of 9h. and 21h. Observations will be made at 9h. and 17h., as at the health resorts, from which reports are received daily by telegraph at the Meteorological Office.

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*Met. Mag., vol. 57, September, 1922, p. 213.

The first Samples of Dust from the Upper Air

It will be remembered that at the Meeting* of the International Union for Geodesy and Geophysics at Rome in May, 1922, funds were provided *inter alia* for the purchase of " jet-instruments " of the type devised by Dr. J. S. Owens for obtaining deposits of atmospheric dust. These instruments were for presentation to countries willing to make observations and forward them to the Bureau of the Union. As the firstfruits of this enterprise, observations are now being reported from Washington, where Professor Kimball is responsible for the observations.

The following details refer to samples of air taken in aeroplane flights on April 6th and April 28th.

	Location.	Dust particles per c.c.		Location.	Dust particles per c.c.
April 6th, 1923	Ground	500	April 28th, 1923.	Ground	680
14.30 to 15.45	3,000 ft.	700	12.0 to 13.30	3,000 ft.	1,750
	6,000 ft.	750		6,000 ft.	160
	9,000 ft.	1,700		Monument (500 ft.)	110
	12,000 ft.	1,350			

On the former occasion there were no clouds, the range of visibility was estimated as 10 (miles ?) on the ground and 20 aloft. By eye observations the haze appeared densest between 6,000 and 8,000 ft. Pilot balloon observations showed a great increase in the strength of the west wind from 15 m.p.h. at 6,000 ft. to 40 m.p.h. at 14,000 ft. It will be seen that the stronger wind held by far the greater number of dust particles in suspension.

On April 28th the sky was overcast, and the flight reached the base of the clouds. There was some rain before the landing. The wind at 6,000 ft. was estimated to be about 60 miles per hour from between south and south-west. In spite of the heavy wind " the flight was extremely smooth on account of no wind shift." It will be noticed that on this occasion the aeroplane passed well above the layer containing the most dust.

The Paulin Aneroid Barometer.

An interesting pamphlet has been issued by the firm Svenska Aktiebolaget Navigator of Stockholm, to advertise the merits of aneroid barometers, constructed on the system invented by Mr. G. Paulin. It is well known that ordinary aneroid barometers suffer from various defects, mostly due to the imperfect elasticity of the capsule, the expansion and contraction of which determine the movements of the hand on the dial. In the new aneroid the pressure to be measured acts on a membrane, to which is attached a spiral spring. This spring can be tightened

* *Met. Mag.*, June, 1922, p. 122.

or slackened by the turning of a screw, and in using the instrument the observer turns this screw until an index connected with the membrane is brought to its zero position. The reading of the instrument is a measure of the force exerted by the spiral spring.

It is claimed that these instruments can be adjusted with great precision and that they are free from all the faults of ordinary aneroids. From a report by Dr. Sandström it appears that Paulin aneroids are to be supplied to all the telegraphic reporting stations in Sweden.

Early Records from Ballons Sondès

IN amplification of his remarks in *The Free Atmosphere in the Region of the British Isles*, page 29, Mr. W. H. Dines, in reply to an enquiry, has provided the following note :—

"I remember that the trace for the Manchester ascent of August 31st, 1906, was not readable, and I think the same remark applies to that of July 1st, 1907. The 1907 observations are certainly not reliable enough for giving extreme values or standard deviations although they will do for forming mean values. Alexander's ascents (1901 and 1903) would not fall in the same category, although no doubt the continental accuracy improved with time. Some cynical person, I have forgotten whom, remarked how scarce gradients exceeding the adiabatic were becoming compared with the number of instances published in early years. Since I got the traces on the same metal plate as the calibration marks, I have never had an instance of such a gradient. In nearly all the tabulations or correlation work I have done, I have cut out 1907 and sometimes 1908."

The details of the first ascent in which Mr. P. V. Alexander sent up a paper balloon carrying one of Teisserene de Bort's instruments (to which Mr. Dines's adjective "continental" would apply) were published in the *Aeronautical Journal*, Vol. V., 1901, page 15. This ascent and the ascents of 1903 were included in the *International Kite and Balloon Ascents.*

Seasonal Variation of Air Temperature at Great Heights

IT is an obvious suggestion that the methods which Lindemann and Dobson have elaborated for making estimates of air temperature from the observations of meteors, should be serviceable in the discussion of the seasonal variation of temperature. From a note published by these authors (Proc. Roy. Soc., A. Vol. 103, p. 339) we learn, however, that at present only one line of attack has led to a definite result ; in this case "the curves seem to indicate that the temperature difference in the upper regions between summer and winter materially exceeds that in the stratosphere."

British Association for the Advancement of Science

THE meeting of the British Association will be held this year at Liverpool, September 12th to 19th, and the programme is to contain a number of papers and demonstrations on meteorological and allied subjects. The official demonstration of weather forecasting from data received locally by wireless telegraphy is to be given again, and there is to be an exhibition of meteorological instruments and diagrams. It is hoped to arrange for the release of a ballon sonde during the meeting. The meteorological luncheon will be held as usual, probably on Friday, September 14th.

Radiation from the Sky

RADIATION MEASURED AT BENSON, OXON, 1923.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays).

Averages for Readings about time of Sunset.

		April	May	June
Cloudless days:				
Number of readings	n	6	8	7
Radiation from sky in zenith ...	πI	463	528	529
Total radiation from sky ...	J	500	563	558
Total radiation from horizontal black surface on earth ...	X	684	728	728
Net radiation from earth ...	$X-J$	184	165	170

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

		April	May	June
Cloudless days:—				
Number of readings	n_0	2	2	2
Radiation from sky in zenith ...	πI_0	36	40	71
Total radiation from sky ...	J_0	47	33	62
Cloudy days:—				
Number of readings	n_1	5	5	8
Radiation from sky in zenith ...	πI_1	129	94	118
Total radiation from sky ...	J_1	88	82	107

Unit for I = gramme calorie per day per steradian per square centimetre.
Unit for J and X = gramme calorie per day per square centimetre.
For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

Erratum

April, 1923, p. 65, *for* "433" the value of J for February *read* "488."

Meteorology and Gunnery

On Monday, 25th June, 1923, the claim of Lieut. Colonel E. Gold and Captain E. M. Wedderburn in respect of the introduction of tables of "Weighting Factors" for enabling the varying winds and temperatures at different heights to be reduced to a single wind and a single temperature (directly applicable by the gunner to his shooting) was considered by the Royal Commission on Awards to Inventors. The case for the claimants was submitted by Mr. James Whitehead, K.C.. Mr. Trevor Watson, who appeared for the Crown, contended that the method did not constitute an invention, design, drawing or process within the meaning of the Royal Warrant of March, 1919, instituting the Commission; and that the said alleged invention, while not within the scope of the applicants' duties, was intimately connected therewith. After argument by Counsel and examination and cross-examination of the claimants, Mr. Trevor Watson admitted the uses and utility of the said alleged invention, so that Mr. Whitehead had no need to call the witnesses who were ready to give evidence supporting the claim.

The Court reserved its decision.

We learn as we go to Press that the Commission is recommending to H.M. Treasury an award of £2,500. We hasten to offer our congratulations.

News in Brief

Dr. Stephen S. Visher, Professor of Geography at the Indiana University, Bloomington, who contributes our leading article, is to be congratulated on the good use he made of the travelling studentship which was awarded to him by the Yale and Indiana Universities and by the Bishop Museum of Honolulu, to enable him to carry out "field investigations" on tropical disturbances and their effects.

After the great disappointment felt when Capt. Roald Amundsen had to abandon his flight across the North Pole, owing to the breakdown of his machine on its trial flight, it is interesting to learn from the Paris *Journal* that a French officer who was preparing an expedition to the Pole by air, and who withdrew when Capt. Amundsen announced his plans, has now decided to carry on with his preparations.

A thunderstorm of exceptional violence visited London in the early morning of the 10th; 50 mm. (2 in.) of rain fell over a large area.

We are informed that Dr. D. la Cour has been appointed Director of the Danish Meteorological Institute in succession to the late Capt. Carl Ryder.

According to *The Times* three toy balloons, liberated at a hospital fête at Gerrard's Cross, are reported to have come down in France, one in Puys de Dôme, five hundred miles from Gerrard's Cross, Bucks.

The Weather of June, 1923

DURING the first week of the month pressure remained high from Iceland to the Azores and low over Scandinavia, so that as in the latter part of May, cool cloudy weather with northerly winds prevailed generally over the British Isles. After this a series of depressions passed eastwards towards Scandinavia with a consequent backing of the winds towards the south-west and an increase in temperature, though in the rear of these depressions the anticyclone off the south-west of Ireland spread repeatedly northwards. Finally, during the last days of the month, the anticyclone moved eastwards over the British Isles and fine warm weather set in. The 23rd, 28th and 29th stand out conspicuously as the three comparatively warm days of the month, 80° F. being reached at London (Camden Square) on the 23rd, and 78° F. at Scarborough and Clacton, while 78° F. occurred at Crieff on the 28th and in the Valley of the Thames on the 29th. At other times in the month the average was seldom reached. Ground frost occurred once or twice in most districts, 20° F. being recorded by the grass minimum thermometer at Balmoral on the 15th, and 23° F. at Eskdalemuir on the 17th. Sunshine records were again very poor, the total for the month being 80 hours or more below the average at several stations. This general lack of sunshine and warmth was accompanied by a shortage of rainfall in England and Ireland. The total for the month (6 mm.) at Kew Observatory has only twice during the last fifty years, in 1895 and 1921, been so low for June. At Calshot the total was 7 mm. Gales and high winds from between south-west and north-west occurred generally in the west and north on the 10th and 13th, while thick fog was experienced at the mouth of the English Channel on the 9th and 15th.

Cold, stormy weather was experienced in Switzerland and northern Italy at the middle of the month. On the 16th a violent thunderstorm damaged the crops, and snow fell in many places, the Senlis Observatory, which was entirely free from snow on June 16th last year, reporting a fall of over 3 feet. Within the next few days falls of a foot and under were reported as low as 2,400 feet. The night temperature at Geneva on the 18th was only 15° F. Abundant snow fell in northern Italy,

temperatures were unusually low and rainstorms accompanied by cold winds were frequent. On the 22nd a heavy fall of snow in Asturias delayed trains, and low temperatures were reported from Teruel, but in south-western Spain the weather was very hot.

Storms and floods were again a marked feature of the month in Canada and the United States and the financial loss was very great. The rivers rose with alarming rapidity in western Canada and much damage was done to roads and property. By the 5th the floods had receded considerably, but these rains have done great service to the farmers. At the same time, much damage was done by bush and forest fires in northern Ontario and Quebec. On the 27th a summer cyclone passed over Toronto, lives were lost, and orchards and farm buildings suffered.

A "heat-wave" visited the north-eastern States in the first week of June and many deaths occurred. On the 6th a severe storm swept over New York City causing many casualties and much damage to property. On the 27th the heat wave was broken by a similar storm which raged with great violence in some parts of the city, but left others untouched. About the second week, the lowlands of Kansas, Oklahoma and Texas were flooded after three days of torrential rain; Trinity River, Texas, rose at the rate of 7 in. per hour.

Reports from India state that the monsoon started badly and was still weak at the end of the month. It reached Bombay on the 12th, and steady but moderate rain set in. A very hot spell was experienced in Calcutta at the middle of the month. On the 13th the temperature was 110° F., the highest recorded during 55 years of observation.

Good rains fell early in the month in all the agricultural and pastoral districts of western Australia, and news from Adelaide on the 14th stated that heavy rains have entirely dispelled the drought conditions there.

The special message from Brazil states that in the north of the country the rainfall was scarce, averaging about 24 mm. below normal, while in the south the average was 23 mm. above normal. In the centre the distribution was irregular. Prospects of the coffee crop continue good. Temperature was generally a little above normal but slight frosts occurred in the south.

Rainfall. June, 1923; General Distribution

England and Wales ...	31	per cent.	of the average	1881-1915.
Scotland	88	,,	,,	,,
Ireland	44	,,	,,	,,
British Isles	51	,,	,,	,,

Rainfall Table for June, 1923

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent. of Av.
Lond.	Camden Square	·42	11	21	Leics	Leicester Town Hall	·39	10	...
Sur.	Reigate, Hartswood	·30	8	...	,,	Belvoir Castle	·69	18	36
Kent.	Tenterden, Ashenden	·66	17	...	Rut.	Ridlington	·69	17	...
,,	Folkestone, Boro. San.	...	..	...	Linc.	Boston, Skirbeck	·50	13	27
,,	Broadstairs	...	..	...	,,	Lincoln, Sessions House	1·19	30	59
,,	Sevenoaks, Speldhurst.	·68	17	...	,,	Skegness, Estate Office.	·51	13	28
Sus.	Patching Farm	·57	15	28	,,	Louth, Westgate	·77	20	36
,,	Eastbourne, Wilm. Sq.	·65	17	35	,,	Brigg	·71	18	34
,,	Tottingworth Park	·51	13	...	Notts.	Worksop, Hodsock	...	..	...
Hants	Totland Bay, Aston	·44	11	24	Derby	Mickleover, Clyde Ho.	·63	16	26
,,	Fordingbridge, Oaklnds	·54	14	29	,,	Buxton, Devon. Hos.	...	..	...
,,	Portsmouth, Vic. Park.	·32	8	18	Ches.	Runcorn, Weston Pt.	·68	17	26
,,	Ovington Rectory	·42	11	18	,,	Nantwich, Dorfold Hall	·67	17	...
,,	Grayshott	·40	10	18	Lancs	Bolton, Queen's Park	1·45	37	...
Berks	Wellington College	·67	17	31	,,	Stonyhurst College	1·53	39	50
,,	Newbury, Greenham	·37	9	17	,,	Southport, Hesketh	·56	14	26
Herts.	Bennington House	...	..	...	,,	Lancaster, Strathspey.	·75	19	...
Bucks	High Wycombe	·50	13	26	Yorks	Sedbergh, Akay	1·31	33	39
Oxf.	Oxford, Mag. College	·39	10	18	,,	Wath-upon-Dearne	·72	18	32
Nor.	Pitsford, Sedgebrook	·62	16	32	,,	Bradford, Lister Pk.	1·00	25	43
,,	Eye, Northolm	·64	16	...	,,	Oughtershaw Hall	2·78	71	...
Beds.	Woburn, Crawley Mill.	·52	13	26	,,	Wetherby, Ribston H.	1·34	34	64
Cam.	Cambridge, Bot. Gdns.	...	..	...	ERY	Hull, Pearson Park	·50	13	24
Essex	Chelmsford, CountyLab	·74	19	...	,,	Holme-on-Spalding	·74	19	...
,,	Lexden, Hill House	·84	21	...	,,	Lowthorpe, The Elms.	·64	16	35
Suff.	Hawkedon Rectory	·67	17	32	NRY	West Witton, Ivy Ho.	·67	17	...
,,	Haughley House	·40	10	...	,,	Pickering, Hungate	·75	19	...
Norf.	Beccles, Geldeston	·68	17	38	,,	Middlesbrough	·74	19	39
,,	Norwich, Eaton	·83	21	43	,,	Baldersdale, Hury Res.	·99	25	...
,,	Blakeney	·74	19	40	Durh.	Ushaw College	1·11	28	51
,,	Swaffham	·63	16	29	Nor.	Newcastle, Town Moor.	1·05	27	48
Wilts.	Devizes, Highclere	·49	12	...	,,	Bellingham Manor	1·48	37	...
Dor.	Evershot, Melbury Ho.	·41	10	18	,,	Lilburn Tower Gdns.	1·01	26	...
,,	Weymouth, Westham	·54	14	30	Cumb	Penrith, Newton Rigg	·71	18	33
,,	Shaftesbury, Abbey Ho.	·59	15	25	,,	Carlisle, Scaleby Hall	·71	18	28
Devon	Plymouth, The Hoe	·36	9	17	,,	Seathwaite	5·00	127	77
,,	Polapit Tamar	·85	22	40	Glam.	Cardiff, Ely P. Stn.	·87	22	35
,,	Ashburton, Druid Ho.	...	..	...	,,	Treherbert, Tynywaun	2·25	57	...
,,	Cullompton	·51	13	24	Carm	Carmarthen Friary	1·19	30	41
,,	Sidmouth, Sidmount	·41	11	20	,,	Llanwrda, Dolaucothy.	1·73	44	51
,,	Filleigh, Castle Hill	1·11	28	...	Pemb	Haverfordwest, Portf'd	1·19	30	44
,,	Hartland Abbey	1·03	26	...	Card.	Gogerddan	...	..	...
Corn.	Redruth, Trewirgie	·63	16	25	,,	Cardigan, County Sch.	·86	22	...
,,	Penzance, Morrab Gdn.	·41	11	18	Brec.	Crickhowell, Talymaes	1·50	38	...
,,	St. Austell, Trevarna	·51	13	20	Rad.	Birm. W.W. Tyrmynydd	·76	19	23
Som	Street, Hind Hayes	·45	11	...	Mont.	Lake Vyrnwy	1·65	42	...
Glos.	Clifton College	·53	14	21	Denb.	Llangynhafal	·95	24	...
,,	Cirencester	·44	11	18	Mer.	Dolgelly, Bryntirion	2·66	68	76
Here.	Ross, County Obsy.	·42	11	20	Carn.	Llandudno	·69	17	34
,,	Ledbury, Underdown.	·39	10	17	,,	Snowdon, L. Llydaw 9	8·75	222	...
Salop	Church Stretton	·45	11	19	Ang.	Holyhead, Salt Island.	·70	18	33
,,	Shifnal, Hatton Grange	·73	19	33	,,	Lligwy	·85	22	...
Staff.	Tean, The Heath Ho.	·63	16	24	Man.	Douglas, Boro' Cem.	...	..	...
Worc.	Ombersley, Holt Lock.	·30	8	...	Guer.	St. Peter Port, Grange.	·49	13	26
,,	Blockley, Upton Wold.	·38	10	14	Wigt.	Stoneykirk, Ardwell Ho	1·29	33	53
War	Farnborough	·54	14	23	,,	Pt. William, Monreith.	1·37	35	...
,,	Birminghm, Edgbaston	·45	11	19	Kirk.	Carsphairn, Shiel.	3·44	87	...

Rainfall Table for June, 1923—*continued*

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm	Per-cent. of Av.
Kirk.	Dumfries, Cargen	1·12	28	40	*Caith*	Loch More, Achfary	11·48	292	310
Dum	Drumlanrig	1·43	36	58	,,	Wick	2·26	57	126
Roxb	Branxholme	1·14	29	51	*Ork.*	Pomona, Deerness	2·11	54	115
Selk.	Ettrick Manse	1·87	47	...	*Shet.*	Lerwick	2·22	56	125
Berk.	Marchmont House	1·10	28	48	*Cork.*	Caheragh Rectory	·64	16	...
Hadd	North Berwick Res.	·96	24	58	,,	Dunmanway Rectory	·65	17	19
Midl	Edinburgh, Roy. Obs.	1·06	27	55	,,	Ballinacurra	·09	2	3
Lan.	Biggar	1·59	40	77	,,	Glanmire, Lota Lo.	·14	4	5
Ayr.	Kilmarnock, Agric. C.	1·49	38	68	*Kerry*	Valencia Obsy.	...	..	...
,,	Girvan, Pinmore	2·28	58	79	,,	Gearahameen	2·10	53	...
Renf.	Glasgow, Queen's Pk.	1·82	46	79	,,	Killarney Asylum	·75	19	26
,,	Greenock, Prospect H.	1·86	47	56	,,	Darrynane Abbey	·70	18	22
Bute.	Rothesay, Ardencr'g.	2·62	67	85	*Wat.*	Waterford, Brook Lo.	·42	11	16
,,	Dougarie Lodge	2·48	63	...	*Tip.*	Nenagh, Cas. Lough	1·11	28	45
Arg.	Glen Etive	...	..	...	,,	Tipperary	1·05	27	...
,,	Oban	3·37	86	...	,,	Cashel, Ballinamona	·60	15	26
,,	Poltalloch	4·06	103	136	*Lim.*	Foynes, Coolnanes	1·29	33	50
,,	Inveraray Castle	4·32	110	109	,,	Castleconnell Rec.	1·50	38	...
,,	Islay, Eallabus	3·27	83	125	*Clare*	Inagh, Mount Callan	...	..	...
,,	Mull, Benmore	16·50	419	...	,,	Broadford, Hurdlest'n.	...	..	...
,,	Mull, Quinish	3·51	89	118	*Wexf*	Newtownbarry	1·01	26	...
Kinr.	Loch Leven Sluice	1·24	31	57	,,	Gorey, Courtown Ho.	·96	24	40
Perth	Loch Dhu	2·20	56	53	*Kilk.*	Kilkenny Castle	·65	17	27
,,	Balquhidder, Stronvar.	1·30	33	34	*Wic.*	Rathnew, Clonmannon	·90	23	...
,,	Crieff, Strathearn Hyd.	·81	21	31	*Cars.*	Hacketstown Rectory	1·77	45	63
,,	Blair, Castle Gardens	·80	20	...	*QCo.*	Blandsfort House	1·06	27	41
,,	Coupar Angus School	·60	15	32	,,	Mountmellick	1·18	30	...
Forf.	Dundee, E. Necropolis	·86	22	48	*KCo.*	Birr Castle	·94	24	41
,,	Pearsie House	·91	23	...	*Dubl.*	Dublin, FitzWm. Sq.	·98	25	50
,,	Montrose, Sunnyside	·74	19	45	,,	Balbriggan, Ardgillan	1·05	27	52
Aber.	Braemar Bank	1·23	31	64	*W.M*	Athlone, Twyford	...	..	...
,,	Logie Coldstone Sch.	·94	24	48	,,	Mullingar, Belvedere	1·67	42	64
,,	Aberdeen, Cranford Ho	1·05	27	58	*Long*	Castle Forbes Gdns.	1·67	42	65
,,	Fyvie Castle	1·26	32	...	*Gal.*	Galway, Waterdale	1·45	37	...
Mor.	Gordon Castle	1·53	39	75	,,	Woodlawn	...	..	...
,,	Grantown-on-Spey	1·65	42	73	*Mayo*	Crossmolina, Enniscoe	2·04	52	68
Na	Nairn, Delnies	·88	22	50	,,	Mallaranny	3·38	86	...
Inv.	Ben Alder Lodge	2·65	67	...	,,	Westport House	·64	16	24
,,	Kingussie, The Birches	1·10	28	...	,,	Delphi Lodge	4·16	106	...
,,	Fort Augustus	2·10	53	103	*Sligo*	Markree Obsy.	2·30	58	...
,,	Loch Quoich, Loan	9·50	241	...	*Ferm*	Enniskillen, Portora	·90	23	...
,,	Glenquoich	9·33	237	190	*Arm.*	Armagh Obsy.	1·06	27	42
,,	Inverness, Culduthel R.	·72	18	...	*Down*	Warrenpoint	1·11	28	...
,,	Arisaig, Faire-na-Squir	4·20	107	...	,,	Seaforde	1·04	26	38
,,	Fort William	3·96	101	113	,,	Donaghadee	·83	21	36
,,	Skye, Dunvegan	2·64	67	...	,,	Banbridge, Milltown	1·33	34	52
,,	Barra, Castlebay	1·18	30	...	*Antr.*	Belfast, Cavehill Rd.	1·23	31	...
R&C	Alness, Ardross Cas.	·96	24	42	,,	Glenarm Castle	1·32	33	...
,,	Ullapool	3·47	88	...	,,	Ballymena, Harryville	1·90	48	65
,,	Torridon, Bendamph	7·32	186	179	*Lon.*	Londonderry, Creggan	2·90	74	103
,,	L. Carron, Plockton	4·47	113	...	*Tyr.*	Donaghmore	·68	17	...
,,	Stornoway	2·64	67	114	,,	Omagh, Edenfel	1·83	47	65
Suth.	Dunrobin Castle	...	..	...	*Don.*	Malin Head	1·40	35	65
,,	Lairg	1·36	35	...	,,	Letterkenny Hos	1·19	30	41
,,	Forsinard	...	..	...	,,	Dunfanaghy	...	..	...
,,	Tongue Manse	2·84	72	139	,,	Narin, Kiltoorish	2·30	58	...
,,	Melvich School	3·13	79	161	,,	Killybegs, Rockmount	2·20	56	58

Correction—Donaghadee, May, *for* "1·11 \| 28 \| 49," *read* "1·18 \| 30 \| 51."

Climatological Table for the British Empire, January, 1923

STATIONS	PRESSURE Mean of Day M.S.L.	PRESSURE Diff. from Normal	TEMPERATURE Absolute Max.	TEMPERATURE Absolute Min.	TEMPERATURE Mean Values Max.	TEMPERATURE Mean Values Min.	TEMPERATURE Mean Values ½ max. and min.	TEMPERATURE Mean Values Diff. from Normal	TEMPERATURE Mean Wet Bulb.	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION Am'nt	PRECIPITATION Diff. from Normal	PRECIPITATION Days	BRIGHT SUNSHINE Hours per day	BRIGHT SUNSHINE Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	mm.	mm.			
London, Kew Obsy.	1022·8	+ 5·2	54	25	47·1	35·7	41·4	+ 2·5	40·1	85	6·9	33	− 12	13	1·6	19
Gibraltar	1024·4	+ 4·9	66	41	58·9	47·1	53·0	− 2·4	48·3	72	3·2	58	− 72	11	...	...
Malta	1015·6	− 0·6	59	43	55·6	49·3	52·5	− 2·1	49·1	83	6·6	103	+ 28	19	3·8	38
Sierra Leone	1010·3	− 0·9	95	69	89·5	74·0	81·7	+ 0·2	73·5	62	4·9	0	− 11	0	...	...
Lagos, Nigeria	1009·4	− 0·5	90	71	87·8	75·3	81·5	+ 0·5	77·5	77	6·7	23	− 5	4	...	...
Kaduna, Nigeria	1011·8	+ 0·2	95	57	91·0	60·4	75·7	+ 1·4	58·7	38	0·6	0	0	0	...	...
Zomba, Nyasaland	1008·2	+ 0·3	89	63	83·9	65·4	74·7	+ 2·3	...	88	6·7	183	−102	21	...	...
Salisbury, Rhodesia	1007·1	− 2·2	96	56	82·0	59·9	70·9	+ 1·4	65·5	72	5·8	146	− 55	21	...	...
Cape Town	1013·4	0·0	91	54	79·7	59·9	69·8	0·0	65·5	66	2·5	13	− 4	4	...	...
Johannesburg	1009·6	− 1·2	85	49	74·5	56·0	65·3	− 0·9	58·7	76	6·1	189	+ 30	17	6·3	46
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Calcutta, Alipore Obsy.	1015·6	+ 0·4	85	47	78·0	54·7	66·3	− 0·1	55·2	80	1·7	0·3	− 10	*0	...	...
Bombay	1012·7	− 0·5	89	65	84·4	68·9	76·7	+ 1·5	65·0	68	1·7	0	− 2	*0	...	...
Madras	1013·7	− 0·4	84	64	81·6	68·7	75·1	− 1·0	70·6	84	4·6	113	+ 90	*6	...	...
Colombo, Ceylon	1010·4	− 0·4	91	70	86·3	72·4	79·3	− 0·5	74·9	73	6·2	177	+ 86	17	...	...
Hong Kong	1020·7	+ 1·3	74	46	65·4	56·1	60·7	+ 0·4	53·9	64	5·4	3	− 34	1	6·7	61
Sandakan	...	...	87	71	84·5	74·0	79·3	− 0·6	75·9	86	...	884	+415	24	...	...
Sydney	1013·4	+ 0·9	103	59	79·9	64·1	72·0	+ 0·4	64·2	62	5·1	46	− 45	7	7·5	56
Melbourne	1008·5	− 4·4	101	49	77·8	56·1	66·9	− 0·6	59·1	54	5·2	25	− 22	10	7·8	54
Adelaide	1010·5	− 2·5	107	51	83·0	60·7	71·9	− 2·2	59·5	44	4·7	18	0	10	9·1	65
Perth, W. Australia	1011·6	− 0·9	99	51	81·2	60·3	70·7	− 3·1	63·5	55	3·3	26	+ 17	3	8·4	64
Coolgardie	1009·2	− 2·2	104	53	92·2	62·1	77·1	− 0·3	64·9	38	3·0	25	+ 13	4	...	...
Brisbane	1008·6	− 2·7	97	64	87·1	70·3	78·7	+ 1·5	72·8	66	4·5	71	− 92	6	9·1	67
Hobart, Tasmania	1003·7	− 6·6	84	45	68·1	53·5	60·8	− 1·5	53·2	60	6·7	57	+ 12	18	7·2	48
Wellington, N.Z.	1009·8	− 3·0	77	48	70·9	57·3	64·1	+ 1·4	58·9	71	7·1	147	+ 61	18	5·5	36
Suva, Fiji	1006·5	− 1·2	91	72	86·6	74·1	80·3	+ 0·4	77·6	84	6·5	190	− 82	22	...	...
Kingston, Jamaica	1015·5	+ 0·2	92	63	87·8	67·5	77·7	+ 0·9	...	67	5·9	8	− 16	2	...	...
Grenada, W.I.	1014·3	+ 1·5	86	69	81·8	71·2	76·5	− 0·5	70·7	71	4·4	78	− 35	21	...	...
Toronto	1018·2	+ 0·8	43	−12	29·8	13·9	21·9	− 0·2	19·3	61	7·7	81	+ 8	21	...	...
Winnipeg	1018·3	− 1·5	42	−35	11·6	− 7·5	2·1	+ 6·5	1·5	...	4·0	42	+ 23	7	...	...
St. John, N.B.	1014·3	− 1·4	43	−15	22·1	7·6	14·9	− 4·3	13·4	65	6·0	141	+ 19	13	...	...
Victoria, B.C.	1014·0	− 1·3	53	24	43·0	36·4	39·7	− 0·4	37·7	88	7·0	163	+ 48	21	...	...

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

53	24	43·0	36·4	39·7	− 0·4	37·7	88	7·0	163	+ 48	21	...	...

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.